GEORGIA INSTITUTE OF TECHNOLOGY — OFFICE OF CONTRACT ADMINISTRATION

PROJECT ADMINISTRATION DATA SHEET

[X] ORIGINAL [ ] REVISION NO. ____

Project No./(Center No.) E-18-637 (R6292-0A0) GTRC/~~GIT~~ DATE 4 / 2 / 87

Project Director: Dr. S.D. Antolovich School/~~Lab~~ Materials Engineering

Sponsor: AFOSR
Bolling AFB, D.C. 20332-6448

Agreement No.: Grant No. AFOSR-87-0162

Award Period: From 5/1/87 To ~~4/30/88~~ 4/30/89 (Performance) ~~5/30/88~~ 5/30/89 Reports

Sponsor Amount:	New With This Change	Total to Date
Contract Value: $	119,770	$ 119,770
Funded: $	119,770	$ 119,770

Cost Sharing No./(Center No.) N/A Cost Sharing: $ None

Title: Cyclic Deformation Damage and Effects of Environment on The NizAl Ordered Alloy At Elevated Temperatures

ADMINISTRATIVE DATA

OCA Contact Brian J. Lindberg x4-4820

1) Sponsor Technical Contact:

Dr. Alan H. Rosenstein
Electronic & Material Sciences
AFOSR/NE
Building 410
Bolling AFB, D.C. 20332-6448
(202) 767-4933

2) Sponsor Issuing Office:

John T. Campellone, Lt. USAF
AFOSR/PKD
Building 410
Bolling AFB, D.C. 20332-6448
(202) 767-5009

Military Security Classification: ~~N/A~~ U
(or) Company/Industrial Proprietary: N/A

ONR Resident Rep. is ACO: ____ Yes X No
Defense Priority Rating: N/A

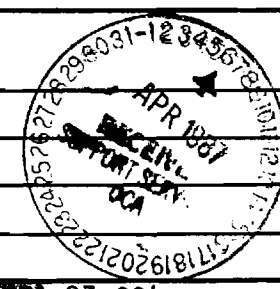
RESTRICTIONS

See Attached N/A Supplemental Information Sheet for Additional Requirements.

Travel: Foreign travel must have prior approval — Contact OCA in each case. Domestic travel requires sponsor approval where total will exceed greater of $500 or 125% of approved proposal budget category.

Equipment: Title vests with Grantee. However, none has been proposed.

COMMENTS:



SPONSOR'S I.D. NO. 02[redacted]1.87.004

COPIES TO:

Project Director
Research Administrative Network
Research Property Management
Accounting
Procurement/GTRI Supply Services
Research Security Services
Contract Support Div.(OCA)(2)
Research Communications
GTRC
Library
Project File
Other ____

FORM OCA 65:1086

GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION

NOTICE OF PROJECT CLOSEOUT

Closeout Notice Date 04/02/91

Project No. E-18-637 Center No. R6292-0A0

Project Director ANTOLOVICH S D School/Lab MAT ENGR

Sponsor AIR FORCE/BOLLING AFB, DC

Contract/Grant No. AFOSR-87-0162 Contract Entity GTRC

Prime Contract No.

Title CYCLIC DEFORMATION DAMAGE & EFFECTS OF ENV ON NIZA1 ORDERED ALLOY AT ELEV

Effective Completion Date 901030 (Performance) 901230 (Reports)

Closeout Actions Required:	Y/N	Date Submitted
Final Invoice or Copy of Final Invoice	Y	910319
Final Report of Inventions and/or Subcontracts	Y	
Government Property Inventory & Related Certificate	Y	
Classified Material Certificate	N	
Release and Assignment	N	
Other	N	

Comments

Subproject Under Main Project No.

Continues Project No.

Distribution Required:

Project Director	Y
Administrative Network Representative	Y
GTRI Accounting/Grants and Contracts	Y
Procurement/Supply Services	Y
Research Property Managment	Y
Research Security Services	N
Reports Coordinator (OCA)	Y
GTRC	Y
Project File	Y
Other	N
	N

NOTE: Final Patent Questionnaire sent to PDPI.

GEORGIA TECH 1885-1985

DESIGNING TOMORROW TODAY

Georgia Institute of Technology
School of Materials Engineering
Atlanta, Georgia 30332-0245
(404) 894- 2816

April 20, 1988

Mr. David Harmon
McDonnel Douglas Corporation
McDonnel Aircraft Company
Box 516
St. Louis, Missouri 63166

Dear Dave,

Enclosed please find test results for the overload fatigue experiments that were done on the IN 718 at 700F and at an overload ratio of 1.8. The overload points on the FCP curves are indicated by arrows. We have had some problems with the welds on the titanium alloys but we now think that the weld problems have been solved. In addition, the main control elements have burned out in the furnace that we are using for testing; new elements are on order and we have switched furnaces in the meantime. We are preparing to run a 1200F hold time test on the IN 718 and the results should be available within a week.

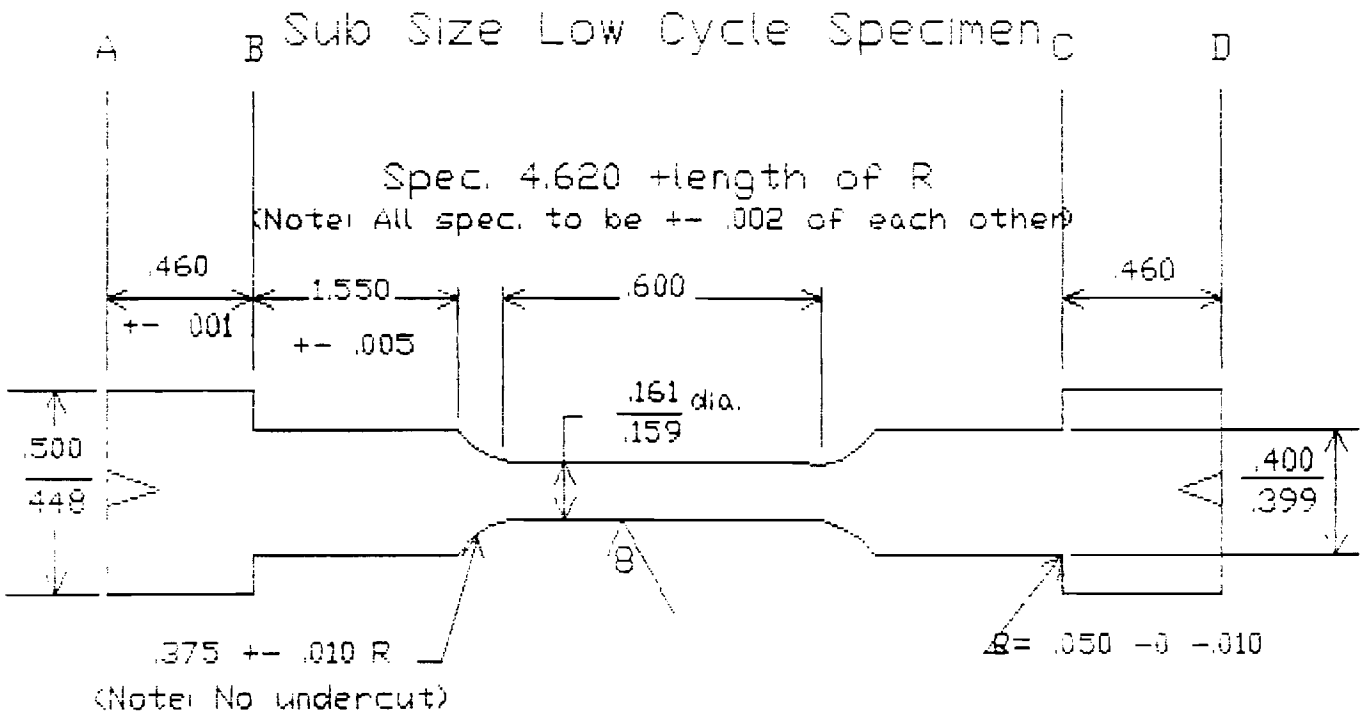
I am also enclosing a drawing of the proposed LCF specimen that we have developed for the aluminides. I would very much appreciate it if you would expedite the machining and also, as I think I requested, get a "chunk" of the aluminide sent to me so we can do some characterization.

I hope all is going well with you. Please call if you have any questions or need more information.

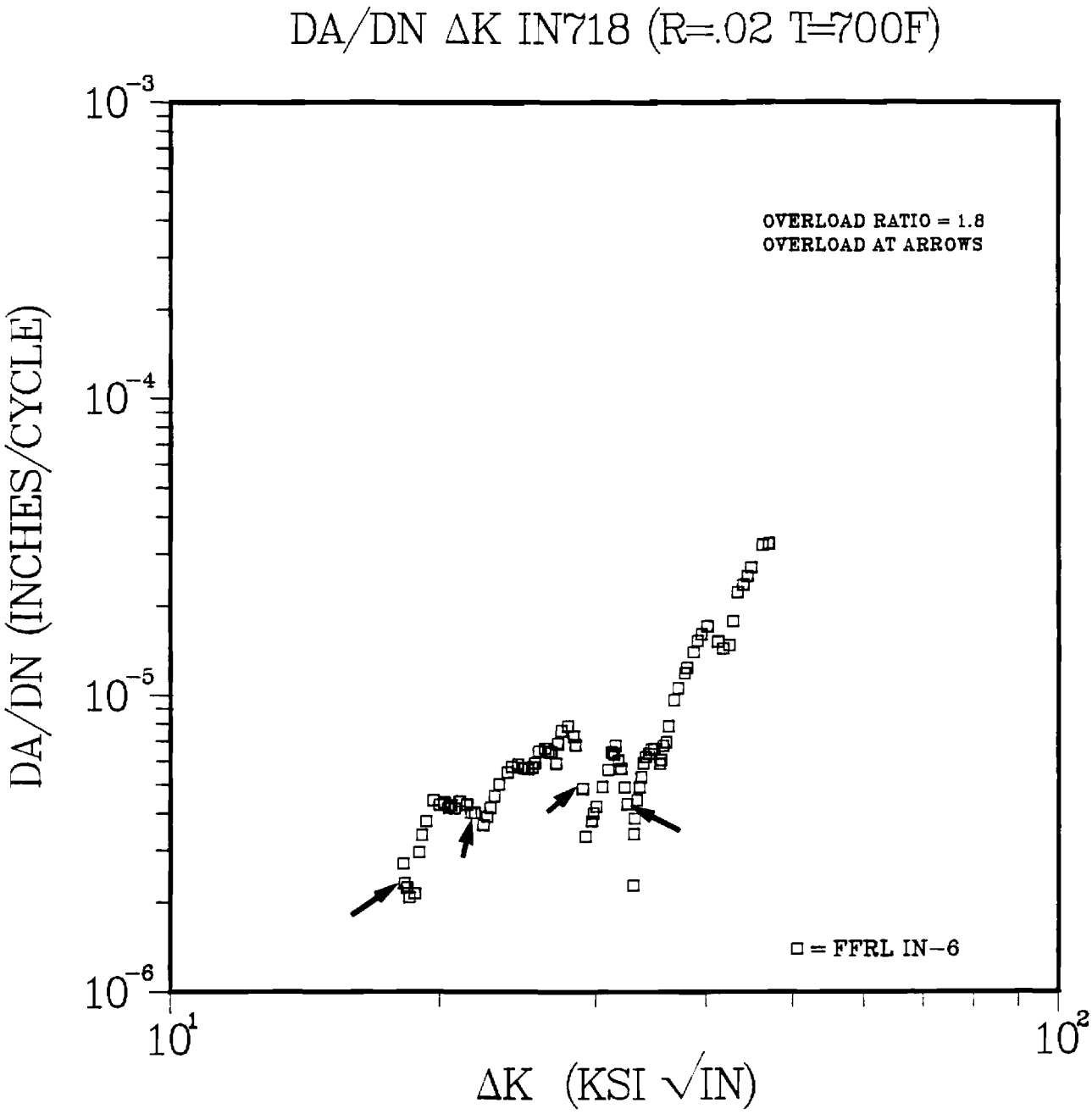
Sincerely,

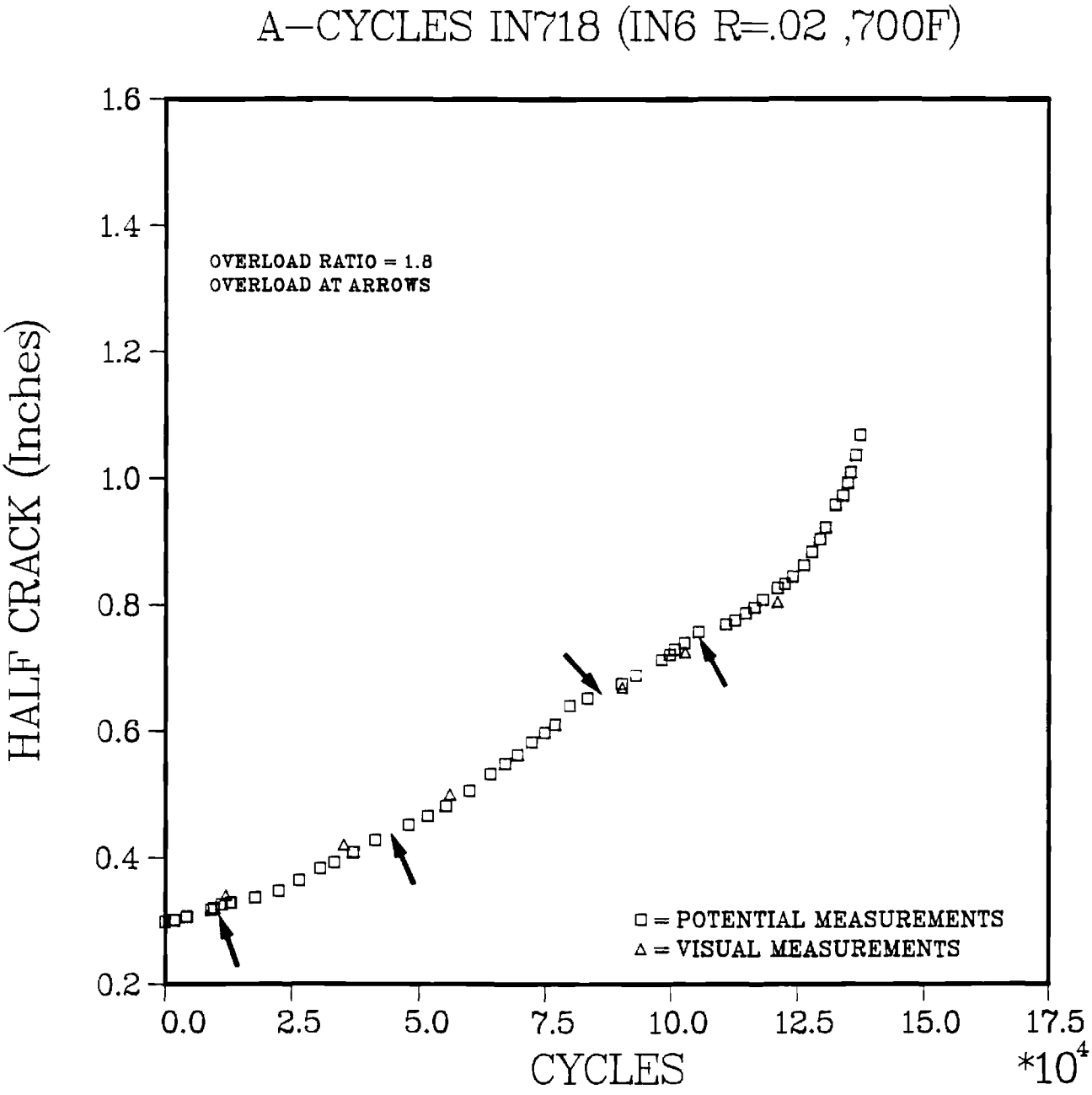
Stephen D. Antolovich, Director
Mechanical Properties Research Lab
Professor and Director
School of Materials Engineering

SDA/ptl



Surfaces A,B,C,D must be parallel within +- .001
and ⊥ to center line
All surfaces 16 except test section
All dimensions in inches


DA/DN ΔK IN718 (R=.02 T=700F)
OVERLOAD RATIO = 1.8
OVERLOAD AT ARROWS
□ = FFRL IN-6
DA/DN (INCHES/CYCLE)
ΔK (KSI √IN)
10^-3
10^-4
10^-5
10^-6
10^1
10^2


A–CYCLES IN718 (IN6 R=.02 ,700F)
HALF CRACK (Inches)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
OVERLOAD RATIO = 1.8
OVERLOAD AT ARROWS
□ = POTENTIAL MEASUREMENTS
△ = VISUAL MEASUREMENTS
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
CYCLES
*10^4

SEVEN POINT INC.POLYNOMIAL METHOD FOR DET. DA/DN

SPECIMEN IDENTIFICATION >> IN-6
LOG BOOK REFERENCE >>
MATERIAL TESTED >> IN718
DATE TESTED >> 2-16-87
INITIALS OF THE TESTOR >> LV
TODAY'S DATE >> 2-17-87

NO. POINTS= 95 OVERLOAD RATIO = 1.8

CCT SPECIMEN B= 0.188 IN. W= 3.000 IN. AM= 0.000 IN.

Pmin= 0.204Kips Pmax=10.204Kips R= 0.020 Poverload=18.367Kips

Test Freq= 6.000Hz. TEMP.= 371.C Environment= AIR

Yield Strength= 170.00 ksi

OBS.NO.		CYCLES		A (Half crack) (Inches)		DELK (Ksi*in**1/2)		DA/DN (in/cycle)
1		0.		0.2980				
2		1800.		0.3008				
3		4200.		0.3063				
4		9000.		0.3173		18.24		0.271E-05
5		9500.		0.3201		18.30		0.232E-05
----------		OVERLOAD		----------		----------		----------
6		11000.		0.3256		18.42		0.224E-05
7		12800.		0.3283		18.53		0.208E-05
8		17700.		0.3362		18.78		0.214E-05
9		20700.		0.3390		18.98		0.296E-05
10		22400.		0.3465		19.14		0.338E-05
11		24100.		0.3539		19.33		0.377E-05
12		26500.		0.3642		19.69		0.443E-05
13		28700.		0.3736		20.00		0.428E-05
14		30650.		0.3831		20.25		0.435E-05
15		32200.		0.3902		20.47		0.417E-05
16		33400.		0.3925		20.61		0.426E-05
17		34900.		0.4016		20.80		0.415E-05
18		37100.		0.4083		21.07		0.439E-05
19		39600.		0.4217		21.47		0.428E-05
20		41400.		0.4280		21.70		0.401E-05
21		43000.		0.4390		21.90		0.401E-05
----------		43700--	OVERLOAD	----------		----------		----------
22		47900.		0.4512		22.40		0.364E-05
23		49900.		0.4575		22.61		0.389E-05
24		51650.		0.4657		22.81		0.418E-05
25		53250.		0.4736		23.04		0.458E-05
26	***	55200.	***	0.4815	***	23.32	***	0.502E-05
27		58350.		0.4988		23.84		0.551E-05
28		59800.		0.5063		24.09		0.575E-05

29	61800.	0.5197	24.48	0.587E-05
30	64000.	0.5323	24.90	0.570E-05
31	65350.	0.5413	25.14	0.565E-05
32	66900.	0.5484	25.41	0.573E-05
33	67950.	0.5535	25.58	0.592E-05
34	69400.	0.5626	25.84	0.650E-05
35	71200.	0.5744	26.27	0.663E-05
36	72200.	0.5831	26.51	0.647E-05
37	73100.	0.5913	26.70	0.642E-05
38	74800.	0.5980	27.04	0.590E-05
39	75900.	0.6043	27.18	0.688E-05
40	76900.	0.6110	27.41	0.759E-05
41	78100.	0.6173	27.87	0.787E-05
42	79800.	0.6409	28.31	0.727E-05
43	80600.	0.6472	28.45	0.680E-05
44	83400.	0.6531	28.99	0.484E-05
45	85800.	0.6654	29.18	0.333E-05
----------	OVERLOAD	----------	----------	----------
46	90200.	0.6756	29.67	0.376E-05
47	91200.	0.6787	29.80	0.400E-05
48	93000.	0.6886	30.04	0.422E-05
49	95700.	0.7004	30.53	0.492E-05
50	98100.	0.7130	30.98	0.562E-05
51	99200.	0.7185	31.21	0.645E-05
52	99700.	0.7213	31.32	0.641E-05
53	100300.	0.7280	31.48	0.633E-05
54	100650.	0.7295	31.57	0.678E-05
55	101800.	0.7362	31.82	0.604E-05
56	102600.	0.7402	32.04	0.566E-05
57	104150.	0.7484	32.35	0.489E-05
58	105400.	0.7575	32.57	0.430E-05
----------	OVERLOAD	----------	----------	----------
59	110250.	0.7665	33.12	0.228E-05
60	110850.	0.7693	33.14	0.341E-05
61	111400.	0.7720	33.19	0.384E-05
62	112600.	0.7756	33.39	0.444E-05
63	113900.	0.7819	33.64	0.491E-05
64	114700.	0.7870	33.80	0.532E-05
65	115500.	0.7909	33.99	0.591E-05
66	116400.	0.7957	34.21	0.622E-05
67	117300.	0.8020	34.46	0.637E-05
68	118100.	0.8083	34.69	0.658E-05
69	118900.	0.8130	34.93	0.662E-05
70	121000.	0.8272	35.48	0.590E-05
71	121600.	0.8295	35.62	0.608E-05
72	122400.	0.8331	35.82	0.678E-05
73	123400.	0.8402	36.09	0.697E-05
74	124000.	0.8449	36.28	0.787E-05
75	125350.	0.8575	36.81	0.965E-05
76	126200.	0.8630	37.20	0.106E-04
77	127400.	0.8795	37.85	0.119E-04
78	127800.	0.8839	38.08	0.124E-04
79	128800.	0.8969	38.73	0.140E-04
80	129400.	0.9039	39.12	0.153E-04
81	129900.	0.9122	39.54	0.161E-04
82	130450.	0.9224	40.14	0.171E-04
83	131700.	0.9472	41.28	0.152E-04
84	132400.	0.9579	41.81	0.144E-04
85	133300.	0.9626	42.49	0.148E-04
86	133900.	0.9728	42.86	0.178E-04

87	134400.	0.9831	43.37	0.223E-04
88	134800.	0.9929	44.01	0.236E-04
89	135100.	1.0000	44.47	0.252E-04
90	135400.	1.0094	44.91	0.270E-04
91	136100.	1.0264	46.23	0.322E-04
92	136400.	1.0362	46.98	0.326E-04
93	136800.	1.0539		
94	137200.	1.0685		
95	138000.	1.0949		

*** : FROM THIS POINT, DATA INVALID PER ASTM E647-83 paragraph 8.6.4

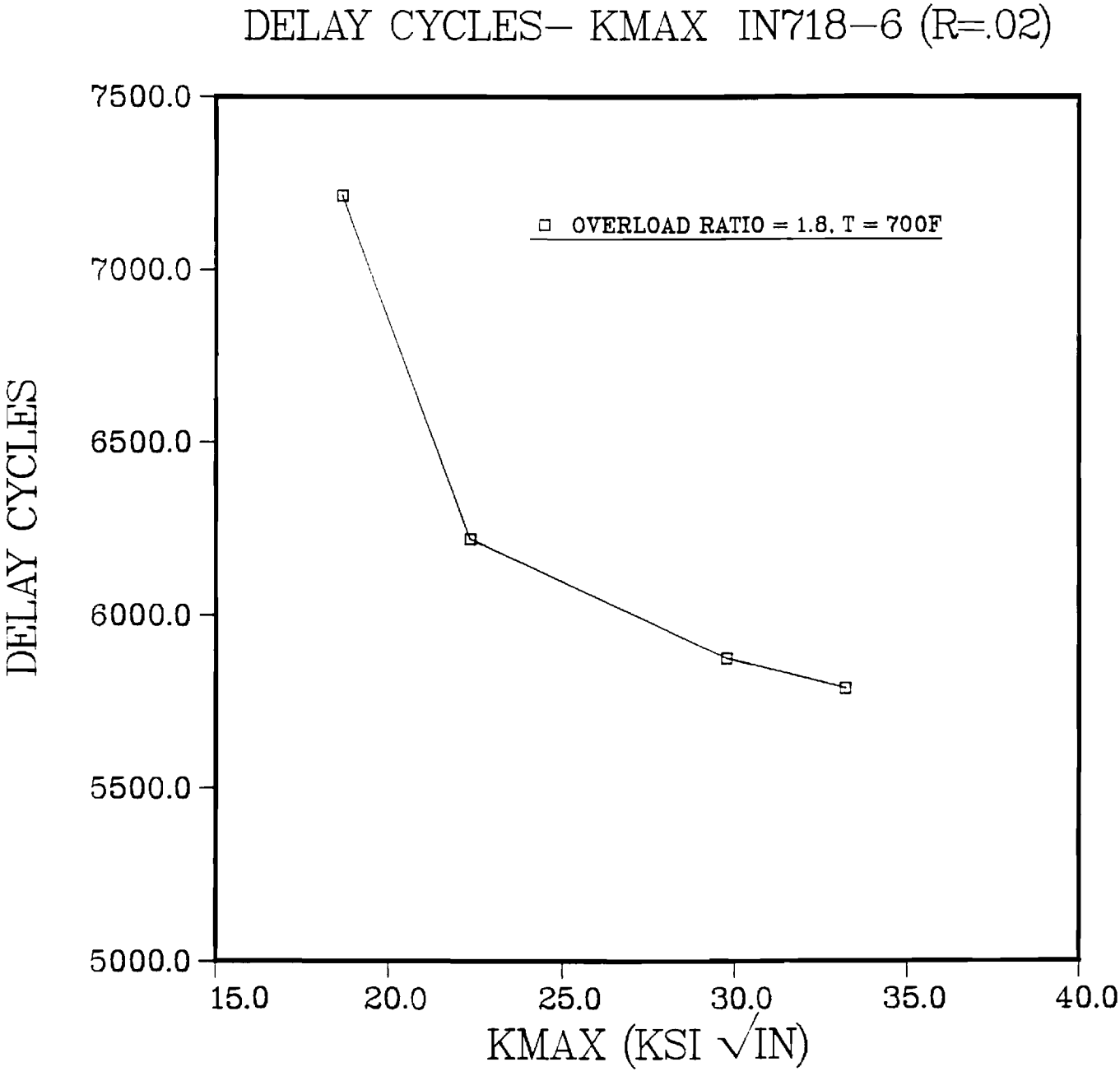
VISUAL MEASUREMENTS

CYCLES	Half crack (inches)
11900	0.340
35300	0.420
56000	0.500
90300	0.670
102800	0.725
121000	0.805

NUMBER OF CYCLES TO RUPTURE = 143300

DELAY CYCLES - KMAX

CYCLES	KMAX (Ksi*in**1/2)
7214	18.67
6220	22.35
5875	29.77
5788	33.23


DELAY CYCLES– KMAX IN718–6 (R=.02)
7500.0
7000.0
6500.0
6000.0
5500.0
5000.0
DELAY CYCLES
OVERLOAD RATIO = 1.8, T = 700F
15.0
20.0
25.0
30.0
35.0
40.0
KMAX (KSI √IN)

GEORGIA TECH 1885-1985

DESIGNING TOMORROW TODAY

Georgia Institute of Technology
School of Materials Engineering
Atlanta, Georgia 30332-0245
(404) 894-

July 5, 1988

Mr. David Harmon
McDonnel Douglas Corporation
McDonnel Aircraft Company
Box 516
St. Louis, Missouri 63166

Dear Dave,

Enclosed please find test results for FCP of Ti 6242 at RT, R=0.10 under a vacuum of $4x10^{-8}$ torr. Please note that there is a very significant difference in the FCP rates in air and in vacuum with the rate in vacuum being about a factor of 2 lower.

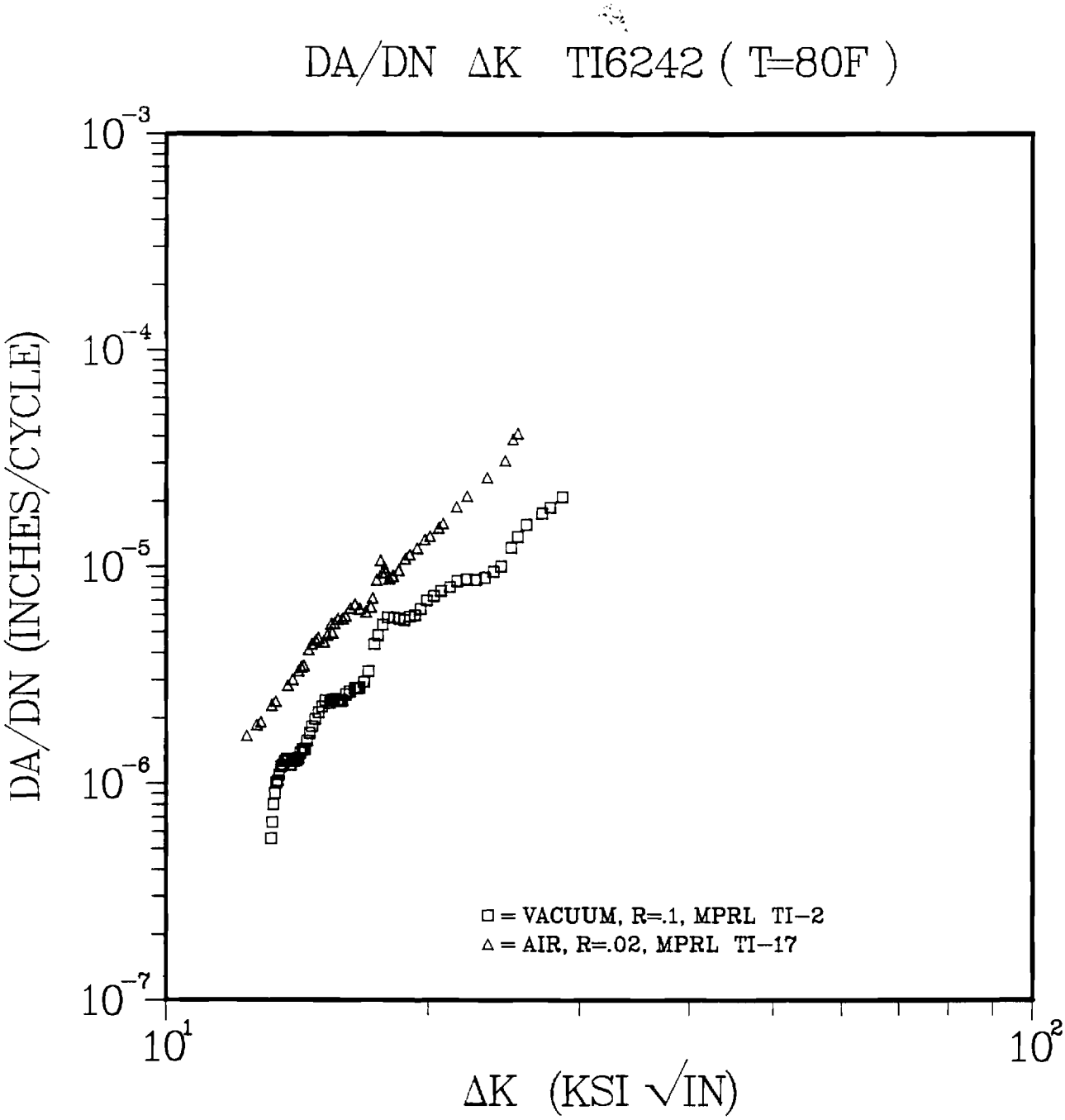
Graphs and all of the raw data are included along with a comparison of the behavior in air under the same conditions. If you have any questions, just give me a call.

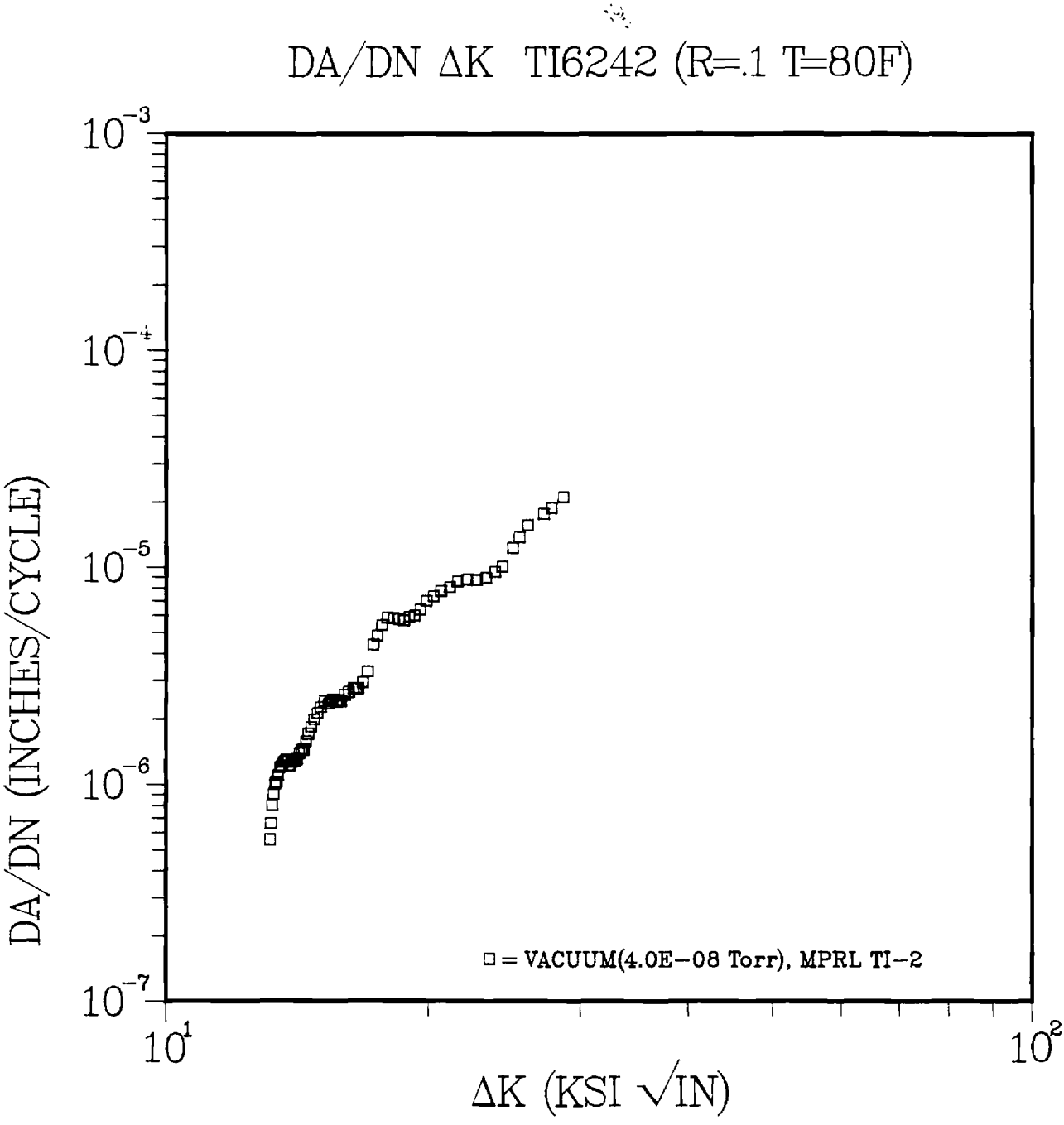
Sincerely,

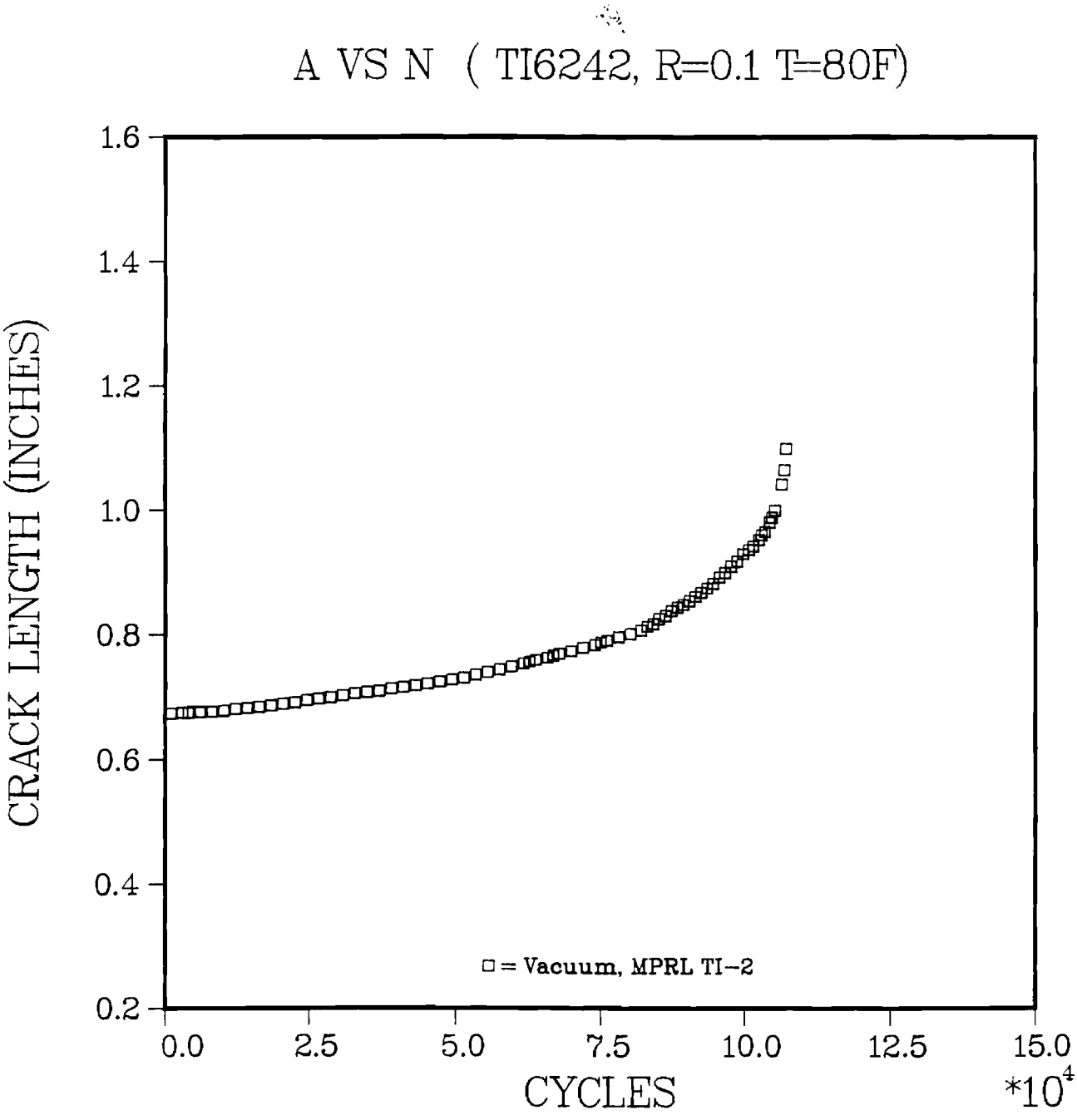
Stephen D. Antolovich, Director
Mechanical Properties Research Lab
Professor and Director
School of Materials Engineering

P.S. We are starting on the vacuum tests of In 718 at RT.

SDA/ptl


DA/DN ΔK TI6242 (T=80F)
DA/DN (INCHES/CYCLE)
10^-3
10^-4
10^-5
10^-6
10^-7
10^1
10^2
ΔK (KSI √IN)
□ = VACUUM, R=.1, MPRL TI-2
△ = AIR, R=.02, MPRL TI-17


DA/DN ΔK TI6242 (R=.1 T=80F)
DA/DN (INCHES/CYCLE)
10^-3
10^-4
10^-5
10^-6
10^-7
10^1
10^2
ΔK (KSI √IN)
□ = VACUUM(4.0E-08 Torr), MPRL TI-2


A VS N (TI6242, R=0.1 T=80F)
CRACK LENGTH (INCHES)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
□ = Vacuum, MPRL TI-2
0.0
2.5
5.0
7.5
10.0
12.5
15.0
CYCLES
*10^4

EN POINT INC.POLYNOMIAL METHOD FOR DET. DA/DN

SPECIMEN IDENTIFICATION >> TI-2
LOG BOOK REFERENCE >>
MATERIAL TESTED >> TI6242
DATE TESTED >> 6-24-88
INITIALS OF THE TESTOR >> LV
TODAY'S DATE >> 7-2-88

NO. POINTS= 72

CT SPECIMEN B= 0.186 IN. W= 1.500 IN. AM= 0.000 IN.

Pmin= 0.040Kips Pmax= 0.400Kips R= 0.100 Test Freq= 9.000Hz.

TEMP.= 80.C Environment= VACUUM Pressure = 4.0E-08 Torr

Yield Strength= 140.00 ksi

OBS.NO.	CYCLES	A (In)	DELK (Ksi*In**1/2)	DA/DN (In/c)
1	1028.	0.6736		
2	3056.	0.6748		
3	4112.	0.6752		
4	6168.	0.6760	13.20	0.556E-06
5	8224.	0.6768	13.23	0.662E-06
6	10280.	0.6783	13.27	0.800E-06
7	12336.	0.6811	13.32	0.903E-06
8	14392.	0.6827	13.37	0.101E-05
9	16448.	0.6846	13.42	0.103E-05
10	18504.	0.6866	13.47	0.110E-05
11	20560.	0.6894	13.54	0.120E-05
12	22616.	0.6913	13.61	0.122E-05
13	24672.	0.6949	13.67	0.127E-05
14	26728.	0.6972	13.74	0.130E-05
15	28784.	0.6992	13.82	0.130E-05
16	30840.	0.7024	13.88	0.122E-05
17	32896.	0.7055	13.95	0.127E-05
18	34952.	0.7075	14.02	0.128E-05
19	37008.	0.7094	14.09	0.128E-05
20	39064.	0.7130	14.16	0.131E-05
21	41120.	0.7154	14.24	0.139E-05
22	43176.	0.7185	14.33	0.144E-05
23	45232.	0.7213	14.41	0.145E-05
24	47288.	0.7244	14.49	0.158E-05
25	49344.	0.7276	14.59	0.171E-05
26	51400.	0.7307	14.69	0.184E-05
27	53456.	0.7354	14.81	0.199E-05
28	55512.	0.7398	14.94	0.213E-05

29	57568.	0.7437	15.08	0.227E-05
30	59624.	0.7488	15.22	0.242E-05
31	61680.	0.7535	15.39	0.235E-05
32	62708.	0.7567	15.47	0.242E-05
33	63736.	0.7594	15.55	0.245E-05
34	65792.	0.7630	15.71	0.241E-05
35	66820.	0.7665	15.79	0.242E-05
36	67848.	0.7693	15.88	0.242E-05
37	69904.	0.7736	16.05	0.258E-05
38	71960.	0.7795	16.22	0.266E-05
39	74016.	0.7839	16.42	0.276E-05
40	75044.	0.7882	16.53	0.275E-05
41	76072.	0.7909	16.63	0.277E-05
42	78128.	0.7965	16.83	0.295E-05
43	80184.	0.8016	17.04	0.331E-05
44	82115.	0.8075	17.30	0.441E-05
45	83160.	0.8134	17.48	0.484E-05
46	84190.	0.8177	17.69	0.543E-05
47	85210.	0.8260	17.95	0.586E-05
48	86352.	0.8307	18.24	0.583E-05
49	87380.	0.8386	18.51	0.578E-05
50	88408.	0.8441	18.75	0.569E-05
51	89436.	0.8488	19.02	0.592E-05
52	90464.	0.8547	19.28	0.600E-05
53	91492.	0.8618	19.58	0.640E-05
54	92520.	0.8685	19.91	0.702E-05
55	93548.	0.8756	20.28	0.737E-05
56	94576.	0.8831	20.68	0.780E-05
57	95680.	0.8933	21.17	0.811E-05
58	96632.	0.9000	21.60	0.864E-05
59	97690.	0.9102	22.15	0.880E-05
60	98750.	0.9181	22.72	0.875E-05
61	99775.	0.9303	23.30	0.895E-05
62	100760.	0.9370	23.86	0.954E-05
63	101500.	0.9429	24.34	0.101E-04
64	102490.	0.9531	25.01	0.123E-04
65	102970.	0.9610	25.45	0.138E-04
66	103500.	0.9661	26.03	0.157E-04
67	104310.	0.9811	27.17	0.177E-04
68	104700.	0.9886	27.76	0.188E-04
69	105215.	1.0000	28.65	0.211E-04
70	106360	1.0420		
71	106840	1.0650		
72	107120	1.0992		

RUPTURE AT N=111404 c

Georgia Tech

School of Materials Engineering

Georgia Institute of Technology
Atlanta, Georgia 30332-0245
(404) 894-

November 9, 1988

David Harmon
McDonnel Douglas Corporation
McDonnel Aircraft Company
Box 516
St. Louis, Missouri 63166

Dear Dave,

Enclosed please find test results for the FCP behavior of IN 718 at 1200F, R=0.02 with a 30 sec hold time after 1000cycles. I have also included comparisons with the no hold data and the 30 sec hold data for your convenience.

Also included with this data set is the data for the FCP behavior of Ti at 1000F, R=0.02 with a 30 sec hold after 1000 cycles. I have also included the same comparisons as for the In 718.

Finally, I am including graphs and a hand-written table of the data for the Ti3Al that I transmitted to you by phone about 6 weeks ago. I forgot if you were sent the graphs or not. In any case you have them now!

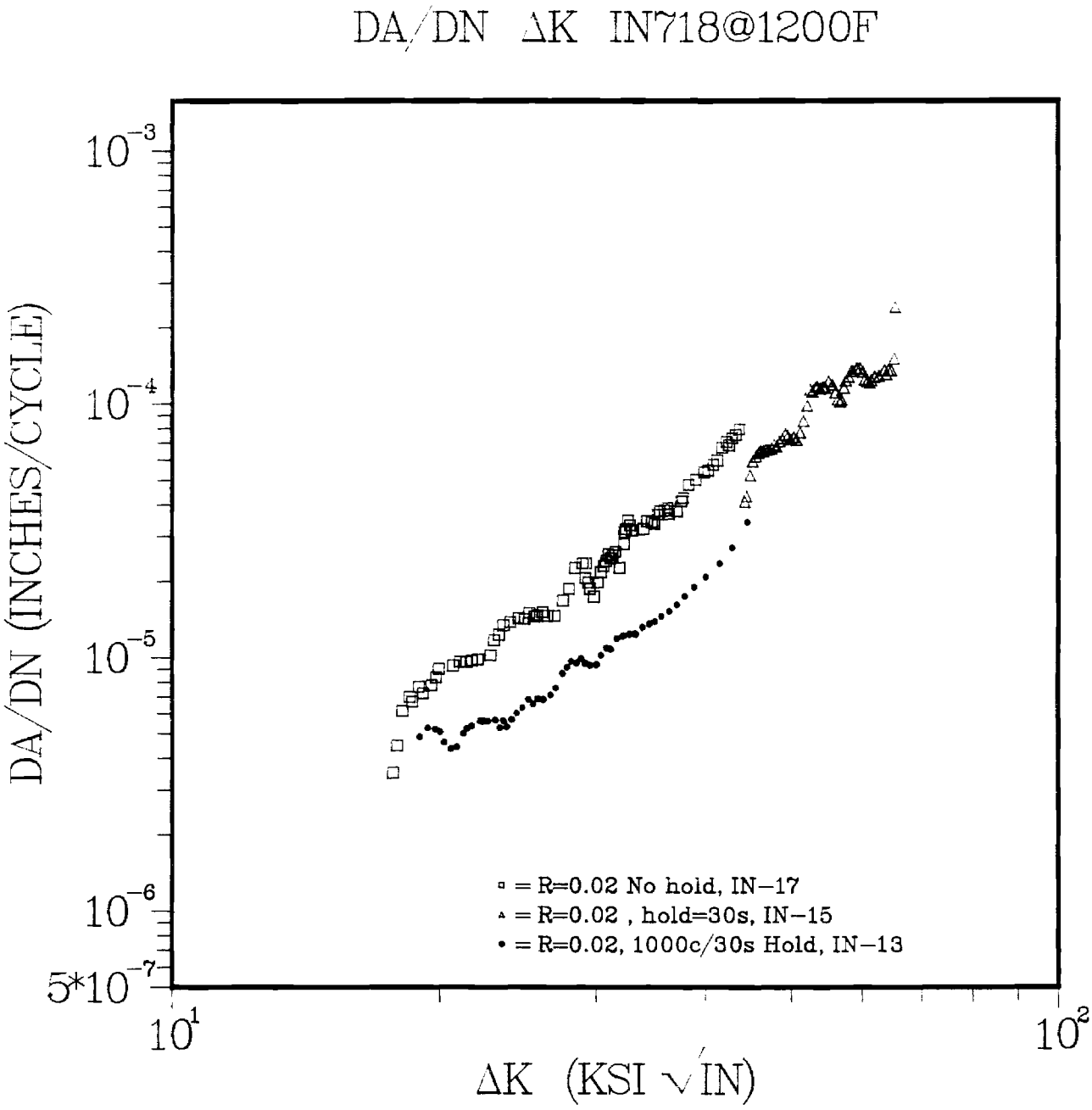
As usual, I have included graphs and all of the raw data. If you have any questions or need more information, just give me a call.

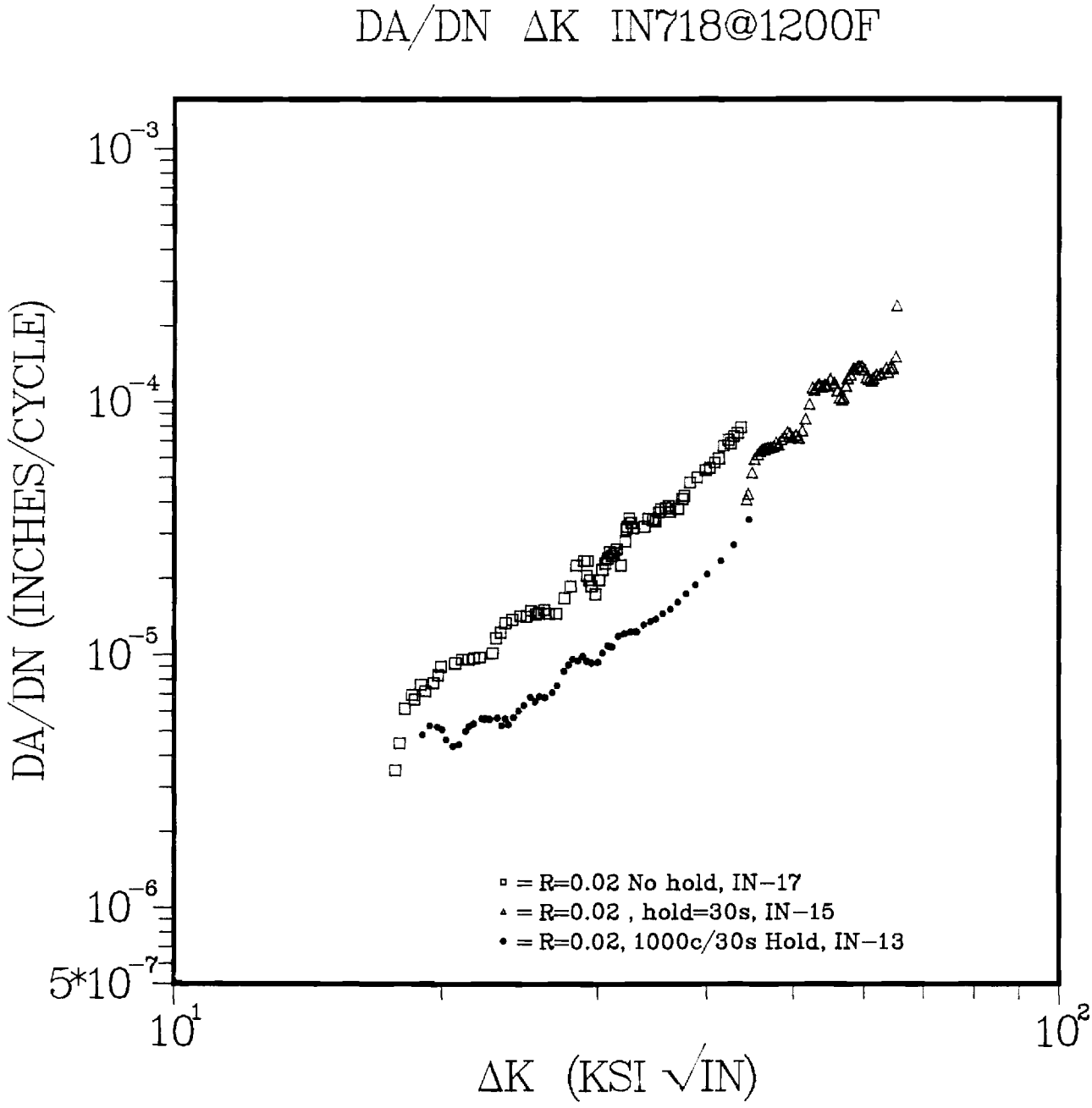
Sincerely,

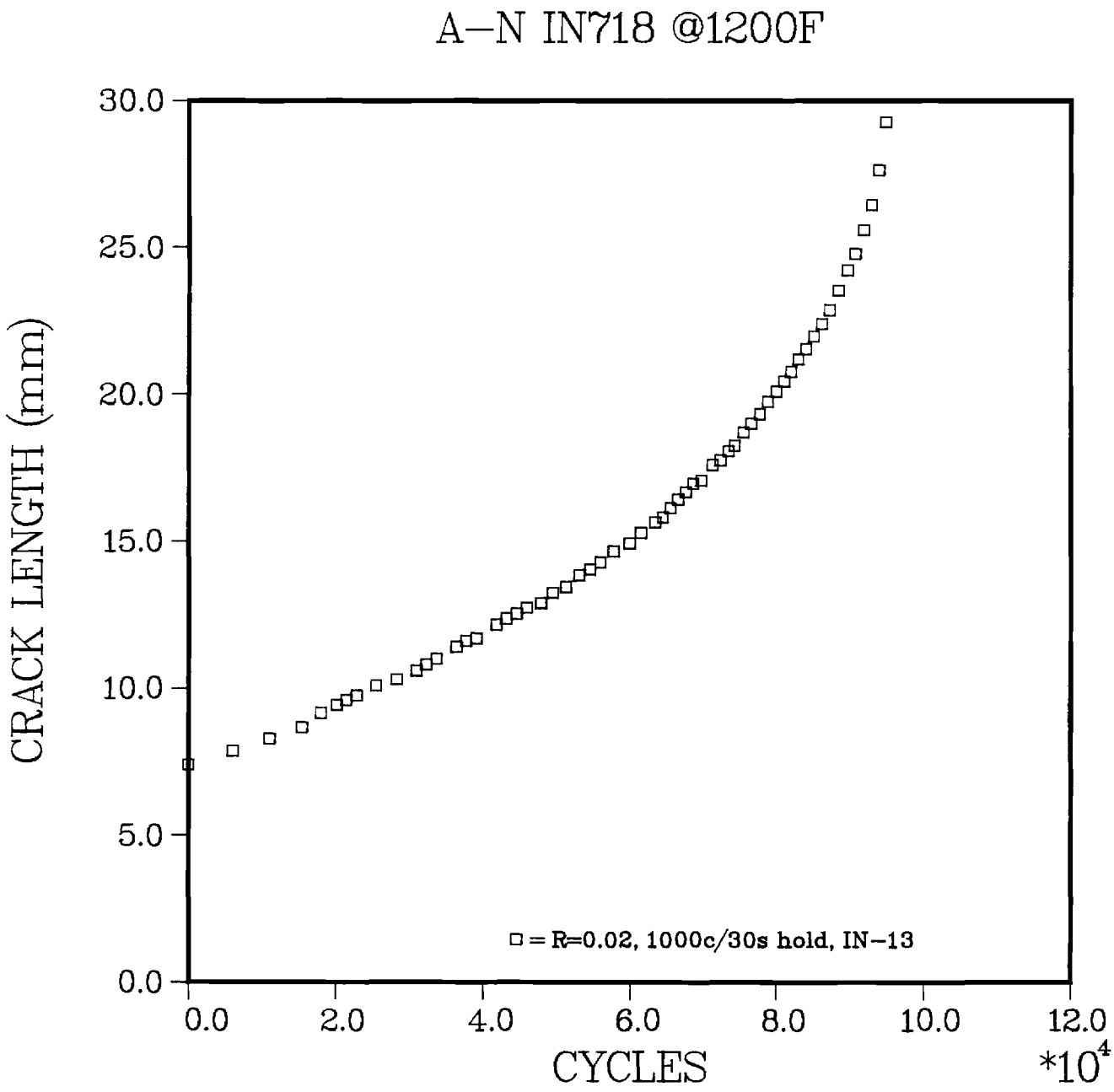
Stephen D. Antolovich, Director
Mechanical Properties Research Lab
Professor and Director
School of Materials Engineering

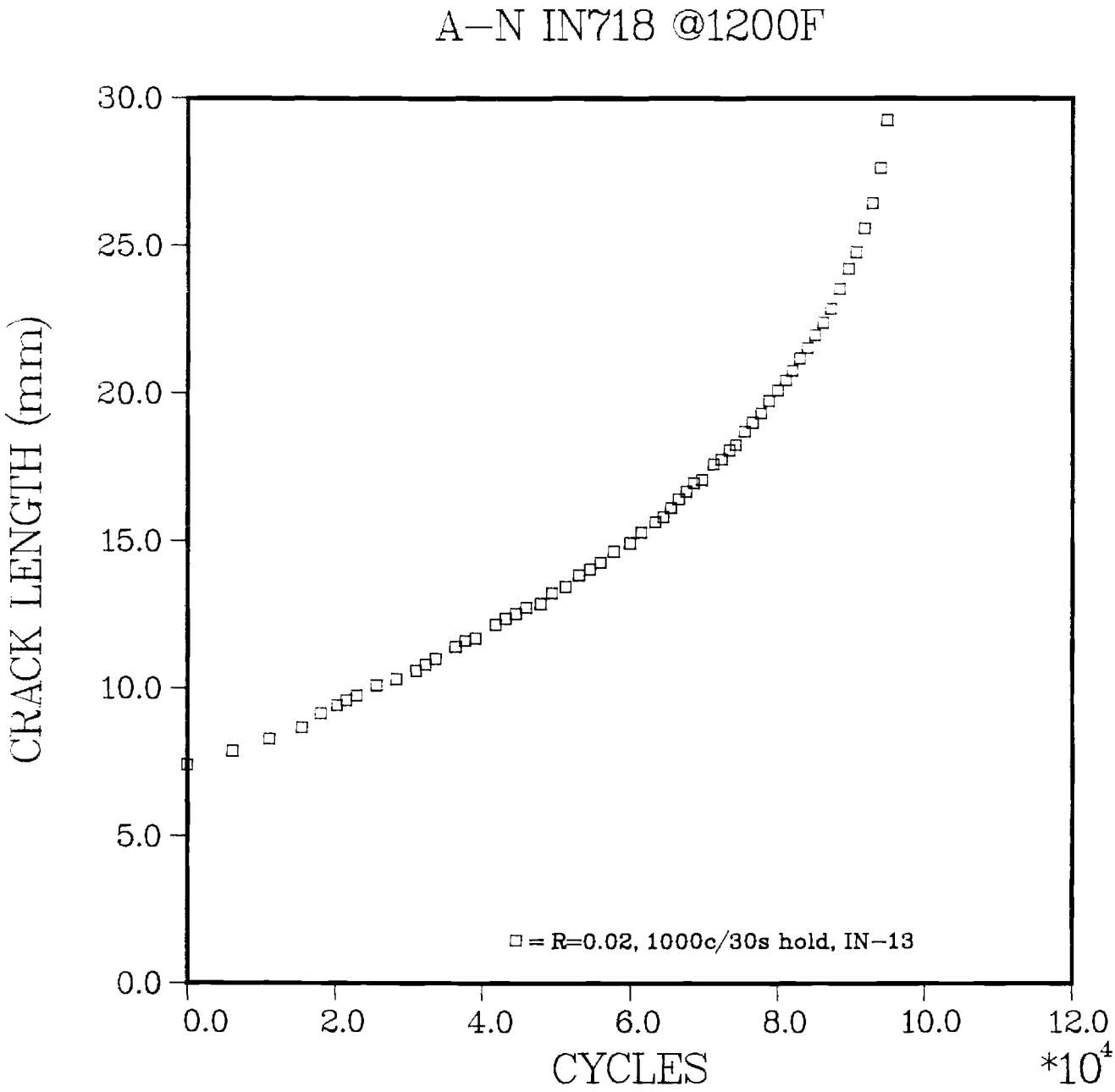
SDA/ptl

Note: Data & graphs for Ti-Al
in Ti, Al pile (Bernard)


DA/DN ΔK IN718@1200F
DA/DN (INCHES/CYCLE)
10^-3
10^-4
10^-5
10^-6
5*10^-7
10^1
10^2
ΔK (KSI √IN)
▫ = R=0.02 No hold, IN-17
▵ = R=0.02 , hold=30s, IN-15
• = R=0.02, 1000c/30s Hold, IN-13


DA/DN ΔK IN718@1200F
DA/DN (INCHES/CYCLE)
10^-3
10^-4
10^-5
10^-6
5*10^-7
10^1
10^2
ΔK (KSI √IN)
▫ = R=0.02 No hold, IN-17
▵ = R=0.02 , hold=30s, IN-15
• = R=0.02, 1000c/30s Hold, IN-13


A–N IN718 @1200F
CRACK LENGTH (mm)
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0.0
2.0
4.0
6.0
8.0
10.0
12.0
CYCLES
*10^4
□ = R=0.02, 1000c/30s hold, IN–13


A–N IN718 @1200F
CRACK LENGTH (mm)
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0.0
2.0
4.0
6.0
8.0
10.0
12.0
CYCLES
*10^4
□ = R=0.02, 1000c/30s hold, IN–13

SEVEN POINT INC.POLYNOMIAL METHOD FOR DET. DA/DN

SPECIMEN IDENTIFICATION >> IN-13
LOG BOOK REFERENCE >>
MATERIAL TESTED >> IN718
DATE TESTED >> 10-11-88
INITIALS OF THE TESTOR >> LSV
TODAY`S DATE >> 10-20-88

NO. POINTS= 59 Waveform= 1000c/30second Hold

CCT SPECIMEN B= 0.185 IN. W= 3.000 IN. AM= 0.000 IN.

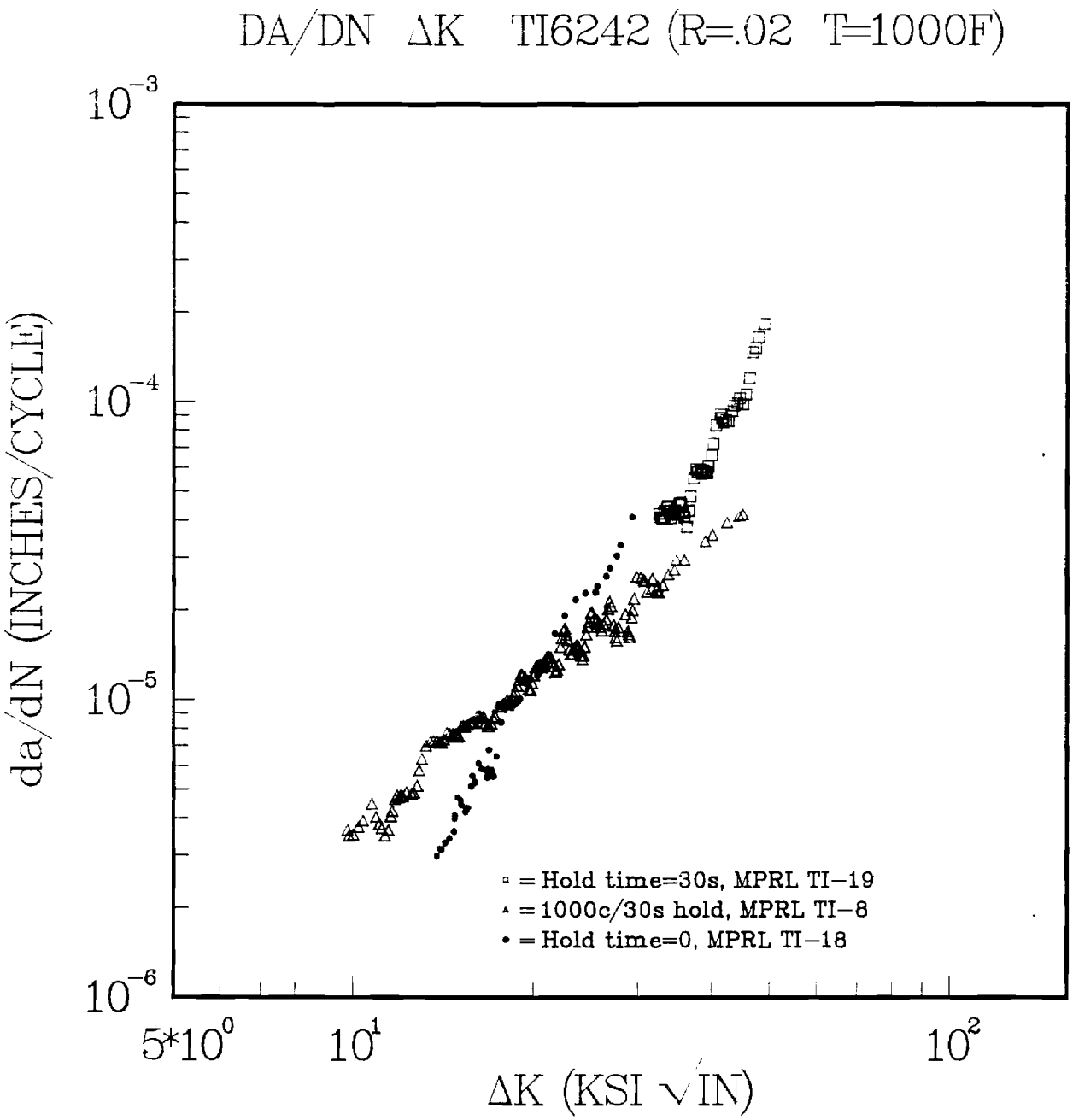
Pmin= 0.200Kips Pmax=10.000Kips R= 0.020 Test Freq= 2.750Hz.

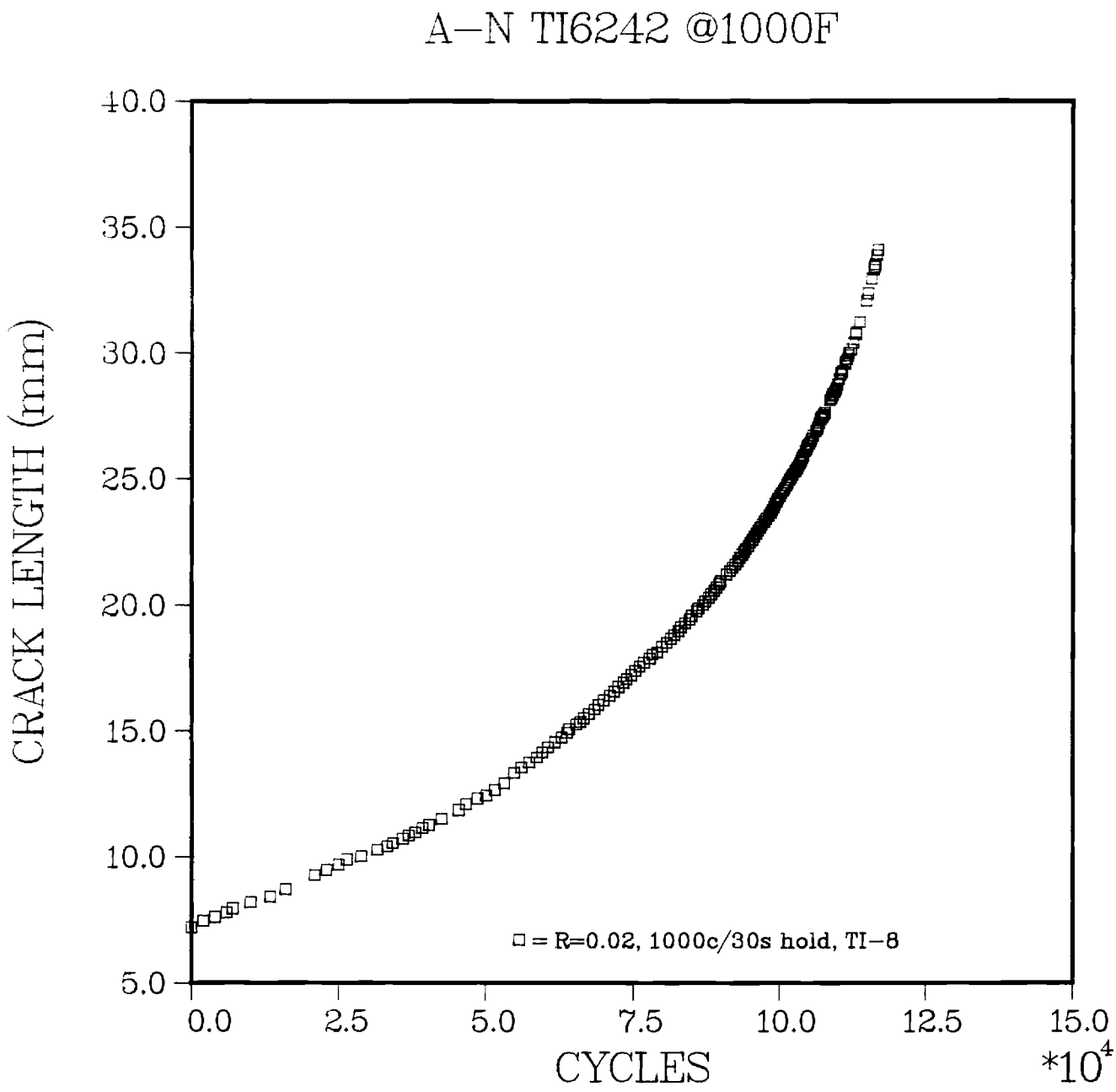
TEMP.= 649.C Environment= AIR Yield Strength= 140.00 ksi

OBS.NO.	CYCLES	A (Half Crack)	DELK (Ksi*In**.5)	DA/DN ("/c)
1	0.	0.2909		
2	6000.	0.3094		
3	11000.	0.3256		
4	15400.	0.3413	19.01	0.484E-05
5	18000.	0.3602	19.40	0.525E-05
6	20200.	0.3709	19.78	0.519E-05
7	21500.	0.3776	20.03	0.507E-05
8	22900.	0.3839	20.23	0.461E-05
9	25600.	0.3976	20.58	0.435E-05
10	28300.	0.4059	20.92	0.443E-05
11	31000.	0.4169	21.28	0.499E-05
12	32350.	0.4252	21.47	0.524E-05
13	33700.	0.4331	21.73	0.536E-05
14	36400.	0.4492	22.19	0.561E-05
15	37700.	0.4571	22.41	0.563E-05
16	39100.	0.4602	22.65	0.558E-05
17	41800.	0.4787	23.10	0.565E-05
18	43150.	0.4870	23.36	0.526E-05
19	44500.	0.4933	23.58	0.562E-05
20	45900.	0.5016	23.79	0.531E-05
21	47800.	0.5075	24.09	0.568E-05
22	49400.	0.5217	24.39	0.602E-05
23	51200.	0.5295	24.75	0.634E-05
24	53000.	0.5453	25.14	0.683E-05
25	54500.	0.5528	25.46	0.655E-05
26	55900.	0.5622	25.76	0.687E-05
27	57700.	0.5772	26.13	0.681E-05
28	59900.	0.5878	26.64	0.712E-05
29	61400.	0.6020	26.98	0.757E-05
30	63350.	0.6161	27.46	0.865E-05
31	64400.	0.6228	27.78	0.916E-05
32	65440.	0.6350	28.09	0.966E-05
33	66500.	0.6465	28.49	0.950E-05

34	67550.	0.6563	28.83	0.995E-05
35	68550.	0.6677	29.16	0.946E-05
36	69650.	0.6720	29.51	0.930E-05
37	71200.	0.6929	30.02	0.937E-05
38	72300.	0.6992	30.37	0.102E-04
39	73400.	0.7114	30.81	0.109E-04
40	74250.	0.7189	31.13	0.108E-04
41	75450.	0.7366	31.65	0.119E-04
42	76540.	0.7484	32.17	0.122E-04
43	77700.	0.7610	32.73	0.124E-04
44	78800.	0.7776	33.25	0.124E-04
45	80000.	0.7913	33.85	0.132E-04
46	81100.	0.8047	34.47	0.136E-04
47	82000.	0.8177	34.98	0.139E-04
48	83000.	0.8343	35.60	0.146E-04
49	84100.	0.8480	36.33	0.152E-04
50	85150.	0.8650	37.03	0.162E-04
51	86230.	0.8819	37.85	0.175E-04
52	87300.	0.9004	38.82	0.190E-04
53	88500.	0.9268	40.01	0.209E-04
54	89750.	0.9535	41.47	0.236E-04
55	90800.	0.9756	42.87	0.273E-04
56	91900.	1.0075	44.59	0.343E-04
57	92980.	1.0409		
58	94050.	1.0878		
59	94950.	1.1520		

cycles to rupture = 90675


DA/DN ΔK TI6242 (R=.02 T=1000F)
da/dN (INCHES/CYCLE)
10^-3
10^-4
10^-5
10^-6
5*10^0
10^1
10^2
ΔK (KSI √IN)
▫ = Hold time=30s, MPRL TI-19
▵ = 1000c/30s hold, MPRL TI-8
• = Hold time=0, MPRL TI-18


A–N TI6242 @1000F
CRACK LENGTH (mm)
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
2.5
5.0
7.5
10.0
12.5
15.0
CYCLES
*10^4
□ = R=0.02, 1000c/30s hold, TI–8

EVEN POINT INC.POLYNOMIAL METHOD FOR DET. DA/DN

SPECIMEN IDENTIFICATION >> TI-8
LOG BOOK REFERENCE >>
MATERIAL TESTED >> TI6242
DATE TESTED >> 10-18-88
INITIALS OF THE TESTOR >> LSV
TODAY`S DATE >> 10-20-88

NO. POINTS= 165 Waveform= 1000 Cycles / 30second Hold Time

CCT SPECIMEN B= 0.185 IN. W= 3.000 IN. AM= 0.000 IN.

Pmin= 0.110Kips Pmax= 5.500Kips R= 0.020 Test Freq= 2.750Hz.

TEMP.= 538.C Environment= AIR Yield Strength= 100.00 ksi

OBS.NO.	CYCLES	A (Half Crack)	DELK (Ksi*In**.5)	DA/DN ("/c)
1	0.	0.2831		
2	2000.	0.2933		
3	4000.	0.2996		
4	6000.	0.3063	9.81	0.365E-05
5	7000.	0.3126	9.86	0.348E-05
6	10000.	0.3217	10.03	0.352E-05
7	13350.	0.3307	10.23	0.374E-05
8	16000.	0.3425	10.41	0.392E-05
9	20900.	0.3650	10.77	0.446E-05
10	22950.	0.3732	10.94	0.403E-05
11	25000.	0.3815	11.08	0.382E-05
12	26400.	0.3894	11.18	0.369E-05
13	28880.	0.3945	11.32	0.349E-05
14	31640.	0.4047	11.47	0.364E-05
15	33350.	0.4098	11.57	0.406E-05
16	34330.	0.4150	11.64	0.423E-05
17	36000.	0.4220	11.76	0.463E-05
18	37000.	0.4272	11.85	0.477E-05
19	38100.	0.4319	11.94	0.470E-05
20	39334.	0.4390	12.04	0.477E-05
21	40470.	0.4437	12.12	0.472E-05
22	42600.	0.4531	12.29	0.488E-05
23	45500.	0.4669	12.54	0.482E-05
24	46740.	0.4760	12.64	0.488E-05
25	48700.	0.4846	12.81	0.514E-05
26	50150.	0.4894	12.91	0.580E-05
27	51600.	0.4980	13.05	0.634E-05
28	53180.	0.5087	13.25	0.701E-05
29	54850.	0.5252	13.48	0.726E-05
30	56100.	0.5335	13.64	0.726E-05
31	57400.	0.5417	13.81	0.724E-05
32	58700.	0.5496	13.95	0.718E-05
33	59600.	0.5575	14.07	0.718E-05

34	60550.	0.5654	14.19	0.737E-05
35	61700.	0.5732	14.35	0.777E-05
36	62850.	0.5807	14.50	0.769E-05
37	63750.	0.5882	14.62	0.754E-05
38	64100.	0.5937	14.68	0.769E-05
39	65350.	0.6012	14.85	0.767E-05
40	65980.	0.6051	14.93	0.751E-05
41	66600.	0.6106	15.01	0.759E-05
42	67500.	0.6177	15.14	0.816E-05
43	68450.	0.6248	15.29	0.819E-05
44	69100.	0.6319	15.39	0.813E-05
45	70000.	0.6390	15.52	0.828E-05
46	71050.	0.6461	15.69	0.836E-05
47	71800.	0.6528	15.80	0.840E-05
48	72500.	0.6598	15.91	0.843E-05
49	73350.	0.6665	16.06	0.874E-05
50	73930.	0.6717	16.15	0.880E-05
51	74750.	0.6780	16.29	0.882E-05
52	75380.	0.6846	16.40	0.869E-05
53	76100.	0.6913	16.52	0.877E-05
54	76850.	0.6976	16.66	0.836E-05
55	77800.	0.7039	16.80	0.817E-05
56	78300.	0.7106	16.88	0.814E-05
57	79120.	0.7138	17.02	0.833E-05
58	79900.	0.7228	17.15	0.868E-05
59	80700.	0.7291	17.29	0.878E-05
60	81400.	0.7354	17.43	0.952E-05
61	82000.	0.7413	17.54	0.950E-05
62	82700.	0.7472	17.69	0.948E-05
63	83150.	0.7535	17.78	0.971E-05
64	83850.	0.7594	17.92	0.973E-05
65	84600.	0.7654	18.08	0.100E-04
66	84980.	0.7709	18.16	0.964E-05
67	85800.	0.7783	18.34	0.998E-05
68	86130.	0.7827	18.42	0.102E-04
69	86850.	0.7882	18.57	0.104E-04
70	87300.	0.7937	18.68	0.107E-04
71	87850.	0.7996	18.81	0.112E-04
72	88300.	0.8051	18.94	0.117E-04
73	88800.	0.8106	19.07	0.122E-04
74	89200.	0.8157	19.19	0.121E-04
75	89650.	0.8213	19.32	0.118E-04
76	89900.	0.8252	19.39	0.119E-04
77	90900.	0.8358	19.66	0.109E-04
78	91500.	0.8413	19.81	0.108E-04
79	91920.	0.8465	19.91	0.114E-04
80	92400.	0.8516	20.05	0.121E-04
81	92850.	0.8567	20.19	0.129E-04
82	93150.	0.8618	20.29	0.131E-04
83	93550.	0.8669	20.43	0.131E-04
84	93900.	0.8717	20.55	0.132E-04
85	94200.	0.8756	20.65	0.129E-04
86	94650.	0.8803	20.79	0.132E-04
87	94950.	0.8854	20.90	0.134E-04
88	95350.	0.8902	21.04	0.139E-04
89	95650.	0.8949	21.16	0.140E-04
90	96000.	0.8996	21.29	0.139E-04
91	96300.	0.9043	21.41	0.139E-04
92	96700.	0.9091	21.56	0.134E-04
93	97000.	0.9138	21.67	0.130E-04

34	60550.	0.5654	14.19	0.737E-05
35	61700.	0.5732	14.35	0.777E-05
36	62850.	0.5807	14.50	0.769E-05
37	63750.	0.5882	14.62	0.754E-05
38	64100.	0.5937	14.68	0.769E-05
39	65350.	0.6012	14.85	0.767E-05
40	65980.	0.6051	14.93	0.751E-05
41	66600.	0.6106	15.01	0.759E-05
42	67500.	0.6177	15.14	0.816E-05
43	68450.	0.6248	15.29	0.819E-05
44	69100.	0.6319	15.39	0.813E-05
45	70000.	0.6390	15.52	0.828E-05
46	71050.	0.6461	15.69	0.836E-05
47	71800.	0.6528	15.80	0.840E-05
48	72500.	0.6598	15.91	0.843E-05
49	73350.	0.6665	16.06	0.874E-05
50	73930.	0.6717	16.15	0.880E-05
51	74750.	0.6780	16.29	0.882E-05
52	75380.	0.6846	16.40	0.869E-05
53	76100.	0.6913	16.52	0.877E-05
54	76850.	0.6976	16.66	0.836E-05
55	77800.	0.7039	16.80	0.817E-05
56	78300.	0.7106	16.88	0.814E-05
57	79120.	0.7138	17.02	0.833E-05
58	79900.	0.7228	17.15	0.868E-05
59	80700.	0.7291	17.29	0.878E-05
60	81400.	0.7354	17.43	0.952E-05
61	82000.	0.7413	17.54	0.950E-05
62	82700.	0.7472	17.69	0.948E-05
63	83150.	0.7535	17.78	0.971E-05
64	83850.	0.7594	17.92	0.973E-05
65	84600.	0.7654	18.08	0.100E-04
66	84980.	0.7709	18.16	0.964E-05
67	85800.	0.7783	18.34	0.998E-05
68	86130.	0.7827	18.42	0.102E-04
69	86850.	0.7882	18.57	0.104E-04
70	87300.	0.7937	18.68	0.107E-04
71	87850.	0.7996	18.81	0.112E-04
72	88300.	0.8051	18.94	0.117E-04
73	88800.	0.8106	19.07	0.122E-04
74	89200.	0.8157	19.19	0.121E-04
75	89650.	0.8213	19.32	0.118E-04
76	89900.	0.8252	19.39	0.119E-04
77	90900.	0.8358	19.66	0.109E-04
78	91500.	0.8413	19.81	0.108E-04
79	91920.	0.8465	19.91	0.114E-04
80	92400.	0.8516	20.05	0.121E-04
81	92850.	0.8567	20.19	0.129E-04
82	93150.	0.8618	20.29	0.131E-04
83	93550.	0.8669	20.43	0.131E-04
84	93900.	0.8717	20.55	0.132E-04
85	94200.	0.8756	20.65	0.129E-04
86	94650.	0.8803	20.79	0.132E-04
87	94950.	0.8854	20.90	0.134E-04
88	95350.	0.8902	21.04	0.139E-04
89	95650.	0.8949	21.16	0.140E-04
90	96000.	0.8996	21.29	0.139E-04
91	96300.	0.9043	21.41	0.139E-04
92	96700.	0.9091	21.56	0.134E-04
93	97000.	0.9138	21.67	0.130E-04

94	97400.	0.9185	21.81	0.124E-04
95	97750.	0.9228	21.93	0.126E-04
96	98150.	0.9276	22.07	0.132E-04
97	98550.	0.9319	22.22	0.151E-04
98	98800.	0.9366	22.33	0.162E-04
99	99050.	0.9409	22.46	0.171E-04
100	99280.	0.9453	22.59	0.174E-04
101	99530.	0.9496	22.72	0.166E-04
102	99770.	0.9539	22.84	0.159E-04
103	100100.	0.9583	22.99	0.148E-04
104	100400.	0.9626	23.12	0.143E-04
105	100730.	0.9669	23.26	0.143E-04
106	100980.	0.9709	23.38	0.148E-04
107	101300.	0.9752	23.53	0.150E-04
108	101530.	0.9791	23.65	0.152E-04
109	101800.	0.9835	23.78	0.151E-04
110	102080.	0.9874	23.93	0.146E-04
111	102334.	0.9913	24.04	0.141E-04
112	102650.	0.9957	24.19	0.137E-04
113	102850.	0.9976	24.28	0.141E-04
114	103100.	1.0016	24.39	0.151E-04
115	103400.	1.0055	24.55	0.166E-04
116	103600.	1.0094	24.68	0.176E-04
117	103750.	1.0130	24.77	0.183E-04
118	104000.	1.0169	24.95	0.195E-04
119	104200.	1.0209	25.08	0.197E-04
120	104550.	1.0283	25.35	0.189E-04
121	104750.	1.0319	25.50	0.183E-04
122	104900.	1.0358	25.59	0.185E-04
123	105200.	1.0394	25.79	0.181E-04
124	105400.	1.0429	25.93	0.176E-04
125	105600.	1.0476	26.07	0.171E-04
126	105830.	1.0520	26.24	0.180E-04
127	106300.	1.0591	26.54	0.186E-04
128	106540.	1.0626	26.71	0.202E-04
129	106700.	1.0661	26.85	0.214E-04
130	106900.	1.0720	27.06	0.206E-04
131	107180.	1.0780	27.32	0.178E-04
132	107300.	1.0811	27.41	0.170E-04
133	107500.	1.0811	27.49	0.162E-04
134	107700.	1.0846	27.64	0.158E-04
135	107900.	1.0878	27.80	0.175E-04
136	108700.	1.1075	28.57	0.194E-04
137	109000.	1.1106	28.86	0.170E-04
138	109150.	1.1138	28.98	0.166E-04
139	109300.	1.1169	29.07	0.163E-04
140	109560.	1.1201	29.29	0.189E-04
141	109700.	1.1228	29.41	0.200E-04
142	109850.	1.1260	29.56	0.219E-04
143	110080.	1.1319	29.86	0.259E-04
144	110400.	1.1406	30.36	0.257E-04
145	110600.	1.1476	30.64	0.252E-04
146	110720.	1.1504	30.81	0.250E-04
147	110950.	1.1535	31.11	0.231E-04
148	111400.	1.1646	31.65	0.236E-04
149	111500.	1.1673	31.78	0.255E-04
150	111780.	1.1724	32.25	0.234E-04
151	111900.	1.1776	32.42	0.240E-04
152	112000.	1.1815	32.53	0.230E-04
153	112380.	1.1866	33.09	0.243E-04

94	97400.	0.9185	21.81	0.124E-04
95	97750.	0.9228	21.93	0.126E-04
96	98150.	0.9276	22.07	0.132E-04
97	98550.	0.9319	22.22	0.151E-04
98	98800.	0.9366	22.33	0.162E-04
99	99050.	0.9409	22.46	0.171E-04
100	99280.	0.9453	22.59	0.174E-04
101	99530.	0.9496	22.72	0.166E-04
102	99770.	0.9539	22.84	0.159E-04
103	100100.	0.9583	22.99	0.148E-04
104	100400.	0.9626	23.12	0.143E-04
105	100730.	0.9669	23.26	0.143E-04
106	100980.	0.9709	23.38	0.148E-04
107	101300.	0.9752	23.53	0.150E-04
108	101530.	0.9791	23.65	0.152E-04
109	101800.	0.9835	23.78	0.151E-04
110	102080.	0.9874	23.93	0.146E-04
111	102334.	0.9913	24.04	0.141E-04
112	102650.	0.9957	24.19	0.137E-04
113	102850.	0.9976	24.28	0.141E-04
114	103100.	1.0016	24.39	0.151E-04
115	103400.	1.0055	24.55	0.166E-04
116	103600.	1.0094	24.68	0.176E-04
117	103750.	1.0130	24.77	0.183E-04
118	104000.	1.0169	24.95	0.195E-04
119	104200.	1.0209	25.08	0.197E-04
120	104550.	1.0283	25.35	0.189E-04
121	104750.	1.0319	25.50	0.183E-04
122	104900.	1.0358	25.59	0.185E-04
123	105200.	1.0394	25.79	0.181E-04
124	105400.	1.0429	25.93	0.176E-04
125	105600.	1.0476	26.07	0.171E-04
126	105830.	1.0520	26.24	0.180E-04
127	106300.	1.0591	26.54	0.186E-04
128	106540.	1.0626	26.71	0.202E-04
129	106700.	1.0661	26.85	0.214E-04
130	106900.	1.0720	27.06	0.206E-04
131	107180.	1.0780	27.32	0.178E-04
132	107300.	1.0811	27.41	0.170E-04
133	107500.	1.0811	27.49	0.162E-04
134	107700.	1.0846	27.64	0.158E-04
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141	109700.	1.1228	29.41	0.200E-04
142	109850.	1.1260	29.56	0.219E-04
143	110080.	1.1319	29.86	0.259E-04
144	110400.	1.1406	30.36	0.257E-04
145	110600.	1.1476	30.64	0.252E-04
146	110720.	1.1504	30.81	0.250E-04
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148	111400.	1.1646	31.65	0.236E-04
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151	111900.	1.1776	32.42	0.240E-04
152	112000.	1.1815	32.53	0.230E-04
153	112380.	1.1866	33.09	0.243E-04

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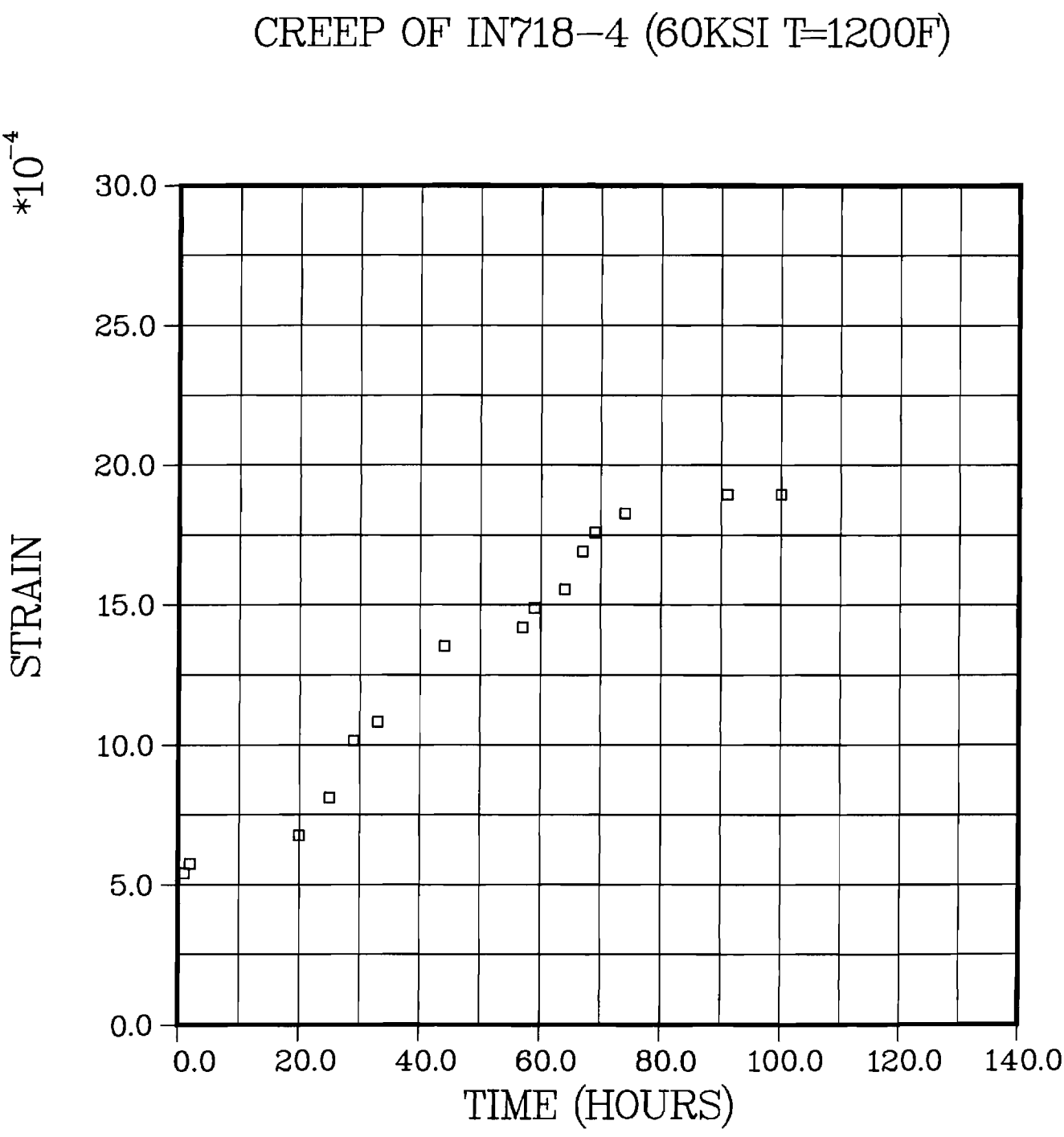
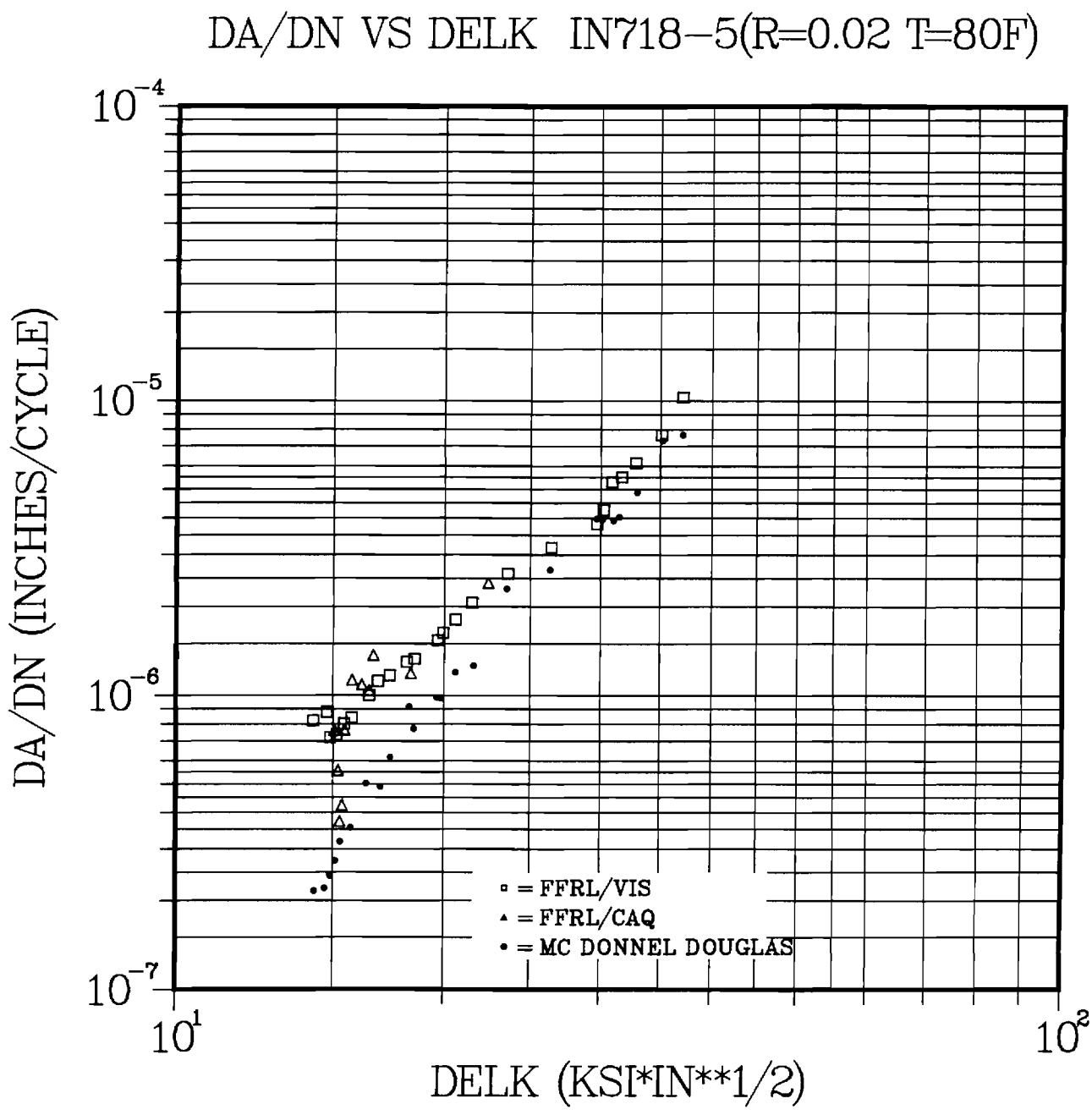
155	113200.	1.2110	34.64	0.273E-04
156	113300.	1.2134	34.87	0.295E-04
157	113850.	1.2299	36.02	0.295E-04
158	115000.	1.2630	39.10	0.341E-04
159	115334.	1.2744	40.26	0.358E-04
160	115900.	1.2976	42.58	0.394E-04
161	116290.	1.3122	44.63	0.414E-04
162	116400.	1.3165	45.26	0.419E-04
163	116500.	1.3205		
164	116800.	1.3346		
165	117000.	1.3429		

Cycles to rupture = 118141


CREEP OF IN718-4 (60KSI T=1200F)
STRAIN
*10^-4
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
TIME (HOURS)


DA/DN VS DELK IN718-5(R=0.02 T=80F)
10^{-4}
10^{-5}
10^{-6}
10^{-7}
DA/DN (INCHES/CYCLE)
10^{1}
10^{2}
DELK (KSI*IN**1/2)
▫ = FFRL/VIS
▲ = FFRL/CAQ
• = MC DONNEL DOUGLAS

DA/DN VERSUS DELK IN718-5
PMAX = 450 lb R =0.02
TEST FREQUENCY = 20 Hz

DELK (KSI*IN**1/2)	DA/DN (IN/CYCLE)
15.07	0.759E-6
15.22	0.555E-6
15.30	0.372E-6
15.39	0.422E-6
15.48	0.764E-6
15.78	0.113E-5
16.18	0.109E-5
16.49	0.104E-5
16.66	0.137E-5
18.36	0.119E-5
22.42	0.241E-5

CRACK LENGTH VERSUS NUMBER OF CYCLES IN718-5
(FROM POTENTIAL MEASUREMENTS METHOD)
PMAX = 450lb R = 0.02
TEST FREQUENCY = 20Hz

NUMBER OF CYCLES	CRACK LENGTH (INCHES)
0	0.077
14300	0.5786
19120	0.6011
26300	0.6097
38300	0.6322
50300	0.6383
62300	0.6453
74300	0.6465
86300	0.6488
98300	0.6581
110300	0.6595
119920	0.6708
127120	0.6964
134300	0.7
146300	0.7047
158300	0.7113
167920	0.7609
182300	0.7714
314300	0.8079
335920	0.8534
341920	0.8949
344720	0.9846

DA/DN VERSUS DELK IN718-5
R=0.02 T=80F ENVIRONMENT=AIR
TEST FREQUENCY=20Hz

VISUAL DATA ACQUISITION

DELK (KSI*IN**1/2)	DA/DN (INCHES/CYCLE)
14.26	8.21E-07
14.77	8.78E-07
14.89	7.20E-07
15.16	7.34E-07
15.45	8.01E-07
15.75	8.41E-07
16.48	1.00E-06
16.86	1.12E-06
17.38	1.17E-06
18.16	1.30E-06
18.52	1.33E-06
19.67	1.54E-06
19.95	1.63E-06
20.60	1.81E-06
21.50	2.06E-06
23.58	2.59E-06
26.40	3.17E-06
29.72	3.82E-06
30.23	4.26E-06
30.90	5.29E-06
31.69	5.51E-06
32.86	6.14E-06
35.11	7.65E-06
37.09	1.03E-05

COMPUTER DATA ACQUISITION

DELK (KSI*IN**1/2)	DA/DN (INCHES/CYCLE)
15.07	7.59E-7
15.22	5.55E-7
15.30	3.72E-7
15.39	4.22E-7
15.48	7.64E-7
15.78	1.13E-6
16.18	1.09E-6
16.49	1.04E-6
16.66	1.37E-6
18.36	1.19E-6
22.42	2.41E-6

THE FATIGUE CRACK GROWTH BEHAVIOR OF Ti-24Al-11Nb AS A FUNCTION OF TEMPERATURE AND LOAD RATIO

A Thesis

Presented to

The Faculty of the Division of Graduate Studies

by

Richard Joseph Bernard

In Partial Fulfillment

of the Requirements for the Degree

Master of Science in Metallurgical Engineering

Georgia Institute of Technology

April 1991

THE FATIGUE CRACK GROWTH BEHAVIOR OF Ti-24Al-11Nb

AS A FUNCTION OF TEMPERATURE AND LOAD RATIO

Approved:

Dr. Stephen D. Antolovich, Chairman

Dr. Ashok S. Saxena

Dr. Miroslav M. Marek

Date approved by Chairman 4/1/91

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